Coloration problems in Silicone injected parts and articles.

Problem

The phenomenon of color differences around the injection point is usually caused by the density differences of the various pigments used and can be exacerbated by a limited dispersion level (pigment particle size). Silicone in motion can drag pigments with different densities and sizes/shapes in varying ways along the flow.

Causes

Especially in and around the injection point, the flow of the silicone changes with each shot, sometimes even moving back and forth. Much depends on the injection system, but generally, the material flow is high at the beginning of a shot and slows as the end of the shot approaches. When the gate is closed, the material can even flow backward slightly due to the back pressure of the material inside the mold. Consequently, the flow of the silicone around the injection point is relatively turbulent and/or multidirectional. If pigments are moved with the flow in different ways and directions, a kind of color separation can occur, seen as concentration differences of those pigments in the parts. Unfortunately, concentration differences of pigments in a part are very visible, and this is what is observed in this case.

This mostly happens with mixed color combinations and hardly ever with a single colorant containing only one pigment. This doesn't mean that there are no pigment concentration differences in a part, but since only one colorant is used, it is hardly visible.

The reason the mentioned green pigment seems to work fine, and if combined with white all remains visually acceptable, is that the density of the green pigment and white pigment are quite close to each other. Thus, they behave similarly, resulting in no visible defect (assuming the green is Cobalt Green and the white is Titanium Dioxide).

Solutions

So far, this explains the phenomenon.

The question, obviously, is how to keep or achieve color homogeneity over the finished part. There is no single solution for this, and some trial and error is usually needed to determine which of the following actions works best to minimize color differences within the finished parts. Not all listed solutions are considered feasible and/or preferred by users, but here are various solutions encountered so far:

- Most colorant pails carry a label stating "stir well before use." Doing this a bit longer than usual can reduce color separation effects.
- Continuously circulating the colorant in the reservoir of the color dosing unit on the injection molding machine can also help.
- Using a longer static mixer mounted on top of the injection molding machine shows improvements because it increases the mixing intensity and therefore the initial homogeneity. It should be noted that this might result in a slight capacity decrease due to the extended pressure drop over the longer static mixer.
- Increasing the cycle time comes with a longer mixing time. This obviously reduces the output level somewhat, but it usually compensates for high scrap rates.
- When producing larger LSR/LIM parts, mold designs can include double or sometimes triple injection points per cavity instead of one per cavity. This reduces material flow and the amount of distance to cover within the molds. Given the cause of this phenomenon, this approach is more applicable to larger parts.
- Lastly, the dispersion level of the colorants is crucial. The smaller the pigment particles in colorant dispersions, the more uniform the final color of the parts will be. Maximizing dispersion levels comes with additional time, labor, energy, and reduced output, making it a balancing act between efficiency and quality, or in other words, "good enough is good enough.". If none of the above measures work well enough, it may be worth discussing with your dye manufacturer their options for increasing the dispersion level of the LSR colorants.
- Lastly, please note that mixing of pigments should be done under vacuum, this is because while larger bubbles will leave the material quite quickly the microscopic bubbles will stay in the material and might grow exponentially in size when heat injected into the mold causing large bubbles, which in turn might cause casting defects.

Liability

Please note that this information is based on years of experience and might not cover all possible causes and solutions, we therefore cannot guarantee any outcome and of course cannot assume any liability. It remains to the customer to test what works best.